Venture Capital and Canadian Public Research Organizations
Summary of Activities

A Report For

The International Development Research Centre
Latin American and Caribbean Regional Office
Montevideo, Uruguay

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May 1998

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1. Introduction

The unique approach and mandate of the IDRC is to help those in need of development assistance to help themselves by finding solutions appropriate to their unique circumstances. Research has been the means used by IDRC to find these appropriate solutions and this approach has more or less been in place since the Centre was created in 1970. Through a comprehensive array of program initiatives, the Centre addresses development in regions of the world and in issue areas that require the most pressing attention. Typically, the approach taken involves the creation and/or transfer of knowledge with the activity involved funded by Canadian taxpayers. This approach or paradigm has had tremendous success over the Centre's 28 years of existence.

Given that the Centre will soon approach its 30th anniversary, it is perhaps a useful juncture to take a look at how this successful approach to development has weathered changing global economic conditions. Over the course of the Centre's history, the world economy has witnessed;

- two major oil price shocks,
- a major recession,
- the reality of globalization manifested in improved transportation and new forms of communications,
- continuing reductions to barriers to trade and investments and the development of new trading relationships.
- the growth and recognition of the importance of small and medium sized scale organizations and projects as fundamental instruments of economic growth and development.

Most significant is a deep shift towards knowledge-based activity in general and, more specifically, an increase in the pervasiveness of technology in every sector and area of economic activity.

This change has brought with it new paradigms in the way people work, how new enterprises are created and grown, how new economic activity is generated and sustained. With value being created in new and different ways, there has been a need to adapt and change older methods of organization, management and financing. It is to the latter issue, financing, that this current document is addressed.

In the past, the building of job-creating enterprises may have been difficult but it was not particularly complex. Technology was relatively constant and was usually a factor that was very much in the background. Protectionism meant that local markets were the main concern and that competition from afar was rare or was not much of a threat. Skill sets did not require years of specialized training and experience. All of that has changed.

Technology is no longer a background issue; it is front and center. The opening up of international markets has amplified the degree to which what happens in outside markets is now a key factor in any approach to business. Innovation has become an overarching thrust of economic activity, especially given the openness of economies and the complexities of technology. Innovation, however, requires a long, steady climb up the "S" curve of growth an effort no less challenging than climbing up a steep treacherous mountain. All of this has meant that the skill sets and resources necessary to create new enterprises have changed and that complexity is very much the key management and developmental challenge.

It is beyond the scope of the present document to delve into these issues in detail; besides there is already vast literature available on these subjects (see for example the writings of Peter Drucker, Tom Peters, Gary Hamel, C. K. Prahad). As a thought-provoking discussion piece, the current document would propose that there are new approaches or paradigms that could complement and act synergistically with the traditional approach of the IDRC toward development.

The changes in the world economy referred to above have put a premium on knowledge and experience in dealing with the complexities of business in the present era. Moreover, changes in the world economy and in local/regional economies have opened up new sources of that key ingredient necessary for starting up any enterprise: **capital**. These two factors -- management expertise and capital -- can be brought together under the auspices of "equity approaches" to new ventures. Equity, perhaps in the form of venture capital, can mean "knowledgeable capital" in the sense that a condition of the provision of capital is the acceptance on the part of the new venture of the management expertise, guidance and connections of the investors.

Equity, that is, investment, as contrasted with donation or the mere transfer of technology, can thus be a more powerful instrument and one that is well-suited to the changed world economy. Knowledgeable investment often means that people with management and entrepreneurial experience become intimately involved advisors or "guides" for new enterprises.

There is yet another interesting and very positive facet in the use of equity approaches to development, especially from the perspective of government development programs. One of the biggest challenges for any new enterprise mounting up the "S" curve is managing cash flow. Cash flow, income coming in, paid expenses (including salaries and interest on debt) going out, is the lifeblood of the enterprise. Bank loans, even if backed up by government loan guarantees, can nonetheless place a great strain on cash flow as these must be repaid with interest. Repayable government grants similarly can place demands on an enterprise's cash flow at just the point when the firm can least afford it.

Taking an equity position, however, provides the option to stakeholders to take a longer term approach to building an enterprise, to creating jobs and adding value to the economy.

For government agencies fostering development -- whether domestic or international -- the equity approach also offers another key advantage: **leverage**. Stated simply, a contribution of capital from one source can often open up the possibility of further contributions from other sources as well.

In the case of an international development agency such as IDRC, this has a particularly interesting twist. In providing a seeding of capital initially, an equity approach could attract further contribution from **local investors**. Often in developing regions, there are sources of capital available such as from existing resource-based enterprises. In many cases, however, these would shy away from start-up enterprises for lack of experience, say, in new technology and lack of credible partners to help provide advice and guidance. On the other hand, given their own knowledge and connections with the local economy, such investors could themselves be a valuable resource in their own right.

To summarize what has been suggested so far, given changes to the world economy and, therefore, to the approaches that need to be take to start up new enterprises, the approach of equity investment offers the advantages of

1. Bringing with it knowledge and expertise in managing new enterprises
2. Levering additional resources
3. Attracting greater local investment interest than would otherwise be the case.

Some Canadian federal government agencies have recognized these advantages and have tried to act upon them. These efforts are summarized later in this document. It is the gist of these results, however, that the efforts of these agencies have been thwarted by the existing federal government legislative framework of the Financial Administration Act (FAA) which does not allow for such agencies to take equity positions of any kind. Some close relationships with venture capital funds have been created to facilitate the sharing of information about projects being funded by conventional grants. While Treasury Board is studying the possibility of changing regulations to allow for equity investment, any action on this is likely to be years away.

Authors of the present document are not in a position to advise as to whether IDRC can or should take this approach in the present circumstances of the FAA. Nonetheless, from the development perspective and especially from the perspective of IDRC's mandate, the equity approach described in general terms above would make a great deal of sense and should be explored for the future.

2. Venture Capital and New Technology in Canada

The modern concept of venture capital can be traced back to the 1950s when a Harvard University Business School professor created a new investment fund to finance and support risk enterprises. The fund started with $US72,000 collected from colleagues and friends in Cambridge, Massachusetts. This was invested for a two-thirds interest in a struggling computer company, Digital Equipment Corporation (DEC). Over the next ten years the fund earned over 200 percent and DEC became one of the largest computer companies in the world.

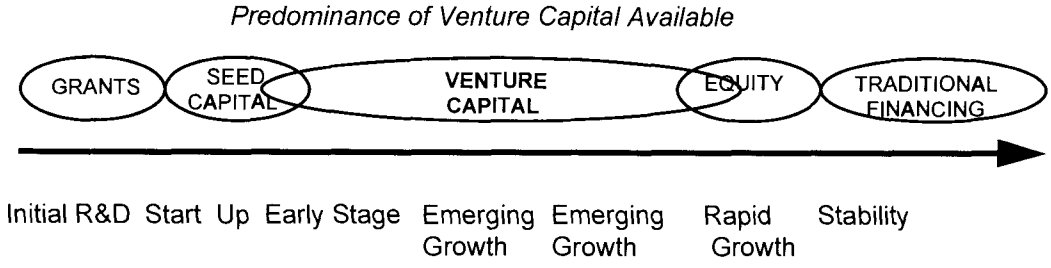
Venture capital is most often associated with new technology development. Such investment is most often research -based. In Canada, over the past five years, around 55 percent of the total venture capital funding has been directed at the technology sector while in the United States the number is about 70 percent. Some high profile Canadian companies have their roots in venture capital financing including:

- Ballard Power (Vancouver, hydrogen fuel cells)
- Cinar Films (Montreal, film and television production and distribution)
- Com Dev (Cambridge, Ontario, space components) and
- Hummingbird (Toronto, computer software).

In the United States, the role of venture capital is legend, in the creation of new enterprises. The list of some of companies which have their origins in venture capital backing include, America Online, Apple Computer, Compaq Computer, Federal Express, Microsoft, Silicon Graphics, Netscape and Cisco Systems.

Venture capital is in essence, capital that is invested by individuals or groups in early stage enterprises. It is equity and not debt financing thus it is not secured by assets. If the organization fails, the money is lost. By definition and placement in the continuum of corporate financing venture capital is at the early stage of the financing for new organizations. It takes place in advance of the time and corporate maturity at which more traditional and generally more conservative financing becomes available to the organization. See Chart 1.

Figure 1 New Technology Financing Instruments



What separates venture capital from other forms of corporate financing, is the higher degree of risk, the earlier stage of application and the scale of the organization in the corporate development continuum. Candidates for venture capital investment are most often small groups of individuals. They are driven by a commitment to the commercial potential around a research finding or an application of a technology. This often occurs just as the technology begins to move out of the research environment of the university or the public or private funded research laboratory.

In return for this higher risk investment, the venture capital sources seek three basic conditions.

1. The investors want to ensure that there is strong intellectual property protection around the idea in order to protect the idea and the market opportunity from competitors at the early or start-up stage.

2. They want to increase the prospects for investment success and as a condition of investment often assume an active role in the company. This can include a variety of involvement ranging from active Board participation, intense external mentoring (directly or bringing in others), the selection of members of the management group or taking a direct role in the management of the organization. A strong management team is essential to venture capital success.

3. The investors are expecting in return an equity position in the organization and minimum returns on the investment of 30 to 40 percent annually.

A high rate of return on the investment is required based on the risky performance history of venture capital-based investments. There is a high failure rate among early stage

business organizations including research or new technology enterprises. The survival rate historically has been 1 in 10, or in case of experienced venture capital individuals or groups 1 in 3. Thus, to off-set those organizations which do not "make it", the venture capitalist is forced to seek a higher rate of return than conventional sources of finance. These conventional financing instruments (debt, public equity or operating lines) appear at a later stage in the organization's development when the risk is substantially reduced.

Venture capital in Canada is not as extensive and pervasive as it is in the United States. Reasons for this later arrival include a greater risk aversion by Canadians and the higher dependency on public rather than private sector investment in research and development. (Indeed, Canada has historically performed a greater share of its R&D in government labs as contrasted to other G7 countries where private sector performance of R&D is stronger.) It should be noted that the state of venture capital participation in the economy is more advanced in Canada than it is in Europe or Asia where large corporations are the main (but limited) sources of financing for early stage technology-based enterprises.

Canadian venture capital activity is gaining momentum. Since 1992 the Canadian venture capital community has invested $C2.9 billion in new mainly technology-related enterprises. In 1996, the venture capital community in Canada invested a record $1.1 billion in 525 companies.

The availability of venture capital in Canada has had a direct impact of the creation of new knowledge-based industries. This sector is now leading "traditional" industry in Canada, driving growth in the economy. See Table 2 below.

Table 1 Technology Companies Compared to Traditional Economic Sectors

Annual Growth Rates of Various Growth Measures 1991-1996

Category	All Survey Companies	Technology Companies
Jobs	26%	34%
Sales	14%	29%
Exports	34%	45%
R&D Expenditures	40%	40%
Taxes Paid	17%	35%
Assets	41%	59%
Equity	59%	71%

Source: Fifth Annual Survey, Economic Impact of Venture Capital, Business Development Bank of Canada, 1997

Sources of venture capital in Canada are dominated by the 17 Labour Sponsored Venture Capital Funds (LSVCs). These funds are the creation of the federal government but require the sponsorship of a labour organization (unions or professional associations). The source of the funds are individual taxpayers who can incorporate LSVC funds into their Registered Retirement Saving Plans. In addition, to encourage participation, individuals can receive an additional federal income tax credit (maximum $C3,500). Five provinces offer an additional incentive by providing an additional provincial tax credit for those LSVC funds that are approved by these provincial governments. Many of the LSVC funds have a single province focus. The only national LSVC funds are directed exclusively at science and technology development: the Canadian Medical Discoveries Fund and the Canadian Science and Technology Growth Fund.

Other sources for venture capital in Canada include individuals (outside of LSVC funds), some but limited corporate participation, small financial participation by some financial institutions and the Business Development Bank of Canada which is an agency of the federal government. In addition, there have been some preliminary steps into the venture capital field directly by a limited number of research organizations (direct or in kind investment) and by certain universities.

Recognition must also be given to the on-going contribution of federal and provincial research organizations and the federal research granting organizations -- The Medical Research Council of Canada (MRC) and the Natural Sciences and Engineering Research Council of Canada (NSERC) -- in providing the original investment for the majority of the research undertaken in Canada. Other key sources of support include the National Research Council, especially the Industry Research Assistance Program (IRAP), and the offering of the Scientific Research and Experimental Development (SR&ED) tax credit which is administered by Revenue Canada. These direct and indirect investments provide much of the feedstock for venture capital investment in Canada.

One of the principal challenges, which Canada has faced in terms of its technical innovation record, has been the inability to exploit fully, the considerable public sector investment ($C2 billion est.) which is made in research and development through the many public agencies including the ones mentioned above. In response nearly all Canadian publicly funded research organizations have moved to establish stronger and sustained linkages with the private sector, to transfer more research with commercial potential to the market place with the participation of the private sector.

Progress is occurring in the participation of federal and provincial research organizations in venture capital activities, but a major frustration are the institutional barriers in the form of legislation and regulations preventing a direct investment role by federal government agencies. Rather, assistance by these organizations in support of venture capital activities is limited to facilitating linkages with sources of venture capital.

3. Canadian Public Research Organizations and Venture Capital

Both the federal and provincial governments have had historic roles in sponsoring research and development activities in Canada. Among the inventions that were developed at the National Research Council, for example, were the paint roller, the music synthesizer and the heart pacemaker. What is common among these inventions is the fact that they were not commercialized by Canadian organizations. Rather, organizations external to Canada gained most of the economic benefits as a result of commercialization outside of Canada. Historically, Canada has been excellent on the "R" side of the research and development equation but not nearly as successful on the "D" side. One of the major reasons for this is the difficulty of linking up the ideas with the private sector money required to undertake further development or commercialization.

It is only in the past several years that serious attention is being paid to the linkage of science and technology to an innovation driven economy which in turns leads to new economic growth and job creation. What follows is a description of the state of this new set of relationships taking into account that they are at an early stage and are often frustrated by existing institutional barriers. It is important that the institutions have awakened to the situation and are struggling with defining new roles for themselves in this changed environment. Formal and informal linkages between these research organizations exist and are being expanded with the venture capital community.

The following section describes these research organizations or key supporting departments in their relationship to the venture capital community in Canada.

3.1 Organizations that support innovative R&D in Canada

Publicly funded research organizations have undergone major transformations over the past decade as political imperatives have reduced the levels of funding available to most organizations and the private/public stakeholders have sought a higher level of relevance to short and medium term needs. In response, organizations have reached out to strengthen the linkages to the private sector including contact with venture capital organizations. In doing so the managers of these research organizations have sought to demonstrate a greater level of accountability and relevance to political masters and private sector stakeholders. Some organizations have been relatively successful in meeting these new challenges, while others are "muddling their way" seeking to achieve new role.

A summary table which identifies type of activities including the following is provided in Tables 13 and 14.

- equity investment
- relationships with venture capital funds
- repayable research and development loans
- non repayable grants for research and development
- participation in consortia

Federal Government research-based agencies reviewed for the present study include:

- Industry Canada
- National Research Council
- Natural Science and Engineering Science Council
- Medical Research Council
- Canadian Space Agency

Most provincial governments sponsor research organizations as well. Their activities can vary widely from original research, to technical support, to industry to routine testing services. All of Canada's provincial research organizations (PROs) have undergone some degree of re-structuring over the past decade. The degree of change has ranged from minor changes in the roles and responsibilities to major changes, including selling of all assets to the private sector. Note that the role of the provincial research organizations varies widely between the provinces. They are a product of economic development initiatives, the degree of industry support, relationships with universities and politics.

For the purpose of this report, the activities of six of the major provincial research organizations are reviewed. These include:

- Nova Scotia
- Quebec
- Ontario
- Saskatchewan
- Alberta
- British Columbia

Government of Canada research organizations

Industry Canada

Ottawa and regional offices
Total Staff: 3,000 (est.)
Total Budget: $C0.9 billion

Major Research & Development Themes

- Broadband technology development and application (Communications Research Centre, CANARIE Inc.)

Industry consortia: PRECARN (robotics and intelligent systems) and CANARIE (broadband network technology and applications)

- Technology Partnerships Program (TPC) to fund technological innovation and improve the adoption of advanced technologies ($C 196 million/year)

Industry Canada At A Glance

Industry Canada, the Federal Department of Industry, is an amalgam of several departments which previously had separate responsibilities for development of individual industry sectors, regional development, science and technology policy, telecommunications regulation and R&D, intellectual property (patents, copyrights), consumer protection and competition policy. It has a network of regional offices in almost every province. Recent years have seen severe cutbacks to the Department's staff complement and budget combined with a repositioning of the agency's role away from that of handing out funds to companies to that of:

- Providing strategic and competitive information products to industry
- Improving conditions for investment Improving innovation & transition to a knowledge-based economy
- Increasing Canada's share of global trade
- Building a fair and competitive market place

The Minister of Industry's "portfolio" also includes responsibility for other agencies that are independent of the Industry Department (see further information in the next sections of this paper):

- Natural Sciences and Engineering Research Council
- National Research Council
- Canadian Space Agency

Table 2 Industry Canada

Type of Activity	State of Participation
Equity investment	No - not permitted (Financial Admin. Act)
Relationship with venture capital	No
Repayable grants for research and development	Yes - Technology Partnerships Canada provides repayable grants to companies
Non-repayable grants for research and development	No
Participation in consortia	Yes - PRECARN, CANARIE
Support for Innovation Infrastructure	
In kind	Yes - CRC
Facilities/incubator	Yes - CRC
Expertise	Yes - CRC
Promotion/marketing	Yes -shared with Department of Foreign Affairs and International Trade

National Research Council of Canada

Ottawa, plus 16 research institutes in 11 Canadian locations; 250 Industrial Technology Advisors in 90 locations across Canada working with 10,000 small and medium-sized firms per year.
Total Staff: 3,153
Total Budget: $C462 million

Major Research & Development Themes

- Biotechnology
- Manufacturing
- Information and telecommunications
- Technology and industry support Technology networks
- Infrastructure technologies
- Core research
- Construction technologies

National Research Council At A Glance

The National Research Council (NRC) was founded in 1916 to provide industrial research and technology support in recognition of the lack of R&D within the private sector in Canada. During and after World War II, the NRC became much more of a research organization, leading to several Nobel prizes and recognition internationally as Canada's premier research organization. Severe cutbacks over the last ten years have brought the NRC closer to its roots in technology outreach and support of industry. The

NRC also has responsibility for industrial standards and codes including building standards.

Table 3 National Research Council

Type of Activity	State of Participation
Equity investment	No - not permitted (Financial Admin. Act)
Relationship with venture capital	Yes - Canadian Science and Technology Growth Fund (non-exclusive)
Repayable grants for research and development	No
Non-repayable grants for research and development	Yes - Industry Research Assistance Program
Participation in consortia	No
Support for Innovation Infrastructure	
In kind	Yes
Facilities/incubator	Yes
Expertise	Yes
Promotion/marketing	Yes - limited

Natural Sciences and Engineering Science Research Council of Canada (NSERC)

Ottawa
Total Staff: 197
Total Budget: $C434 million

Major Research & Development Themes

- Research grants are provided in the following general fields:
- Earth Sciences
- Engineering
- Mathematics, Statistics and Computing Sciences (the largest category)
- Life Sciences
- Physical Sciences

- Grants are also provided, mainly to universities, for major equipment and installations
- A special program matches industry contributions in the creation of research chairs at universities

NSERC At A Glance

NSERC, which is celebrating its 20th anniversary this year, is the national instrument for making strategic investments to "foster the discovery and application of knowledge

through the support of university research and the training of scientists and engineers." Grants are made solely on the basis of excellence determined by peer review. It functions at arm's-length from the federal government. It Board is drawn from both universities and industry. NSERC administers the Networks of Centres of Excellence program on behalf of Industry Canada (other than health sciences areas, which are administered by MRC - see below).

Table 4 NSERC

Type of Activity	State of Participation
Equity investment	No - not permitted (Financial Admin. Act)
Relationship with venture capital	Yes - Canadian Science and Technology Growth Fund (non-exclusive)
Repayable grants for research and development	No
Non-repayable grants for research and development	No
Participation in consortia	Indirectly
Support for Innovation Infrastructure	
In kind	No
Facilities/incubator	No
Expertise	No
Promotion/marketing	No

Medical Research Council of Canada

Ottawa
Total Staff: 66
Total Budget: $C 237 million

Major Research & Development Themes

- Funding of clinical and applied research in biomedical sciences

Medical Research Council At A Glance

The Medical Research Council (MRC) is a granting agency, similar in operation to NSERC (see above), for health and medical-related research. It also provides programs supporting research training of health scientists and acts as an advisor on health research to the federal Health Minister. MRC does not operate laboratories of its own nor does it employ its own scientists. The research it supports is carried out in universities, hospitals and research institutes across the country. MRC administers the health sciences aspects of

the Networks of Centres of Excellence program and is responsible for and administers the Canadian Genome Analysis and Technology Program. (CGAT).

Table 5 Medical Research Council

Type of Activity	State of Participation
Equity investment	No - not permitted (Financial Admin. Act)
Relationship with venture capital	Yes - Canadian Medical Discoveries Fund (non-exclusive)
Repayable grants for research and development	No
Non-repayable grants for research and development	No
Participation in consortia	No
Support for Innovation Infrastructure	
In kind	No
Facilities/incubator	No
Expertise	No
Promotion/marketing	No

Canadian Space Agency

St. Hubert, Quebec
Total Staff: NA
Total Budget: $C260 million

Major Research & Development Themes

The Agency's R&D program is focused on technologies relevant to its priority areas:

- earth observation
- satellite communication
- robotic systems
- science missions

Technologies used for these programs require

- low weight
- low power consumption
- radiation resistance
- reliability under a wide temperature range

The following are typical applications:

- Digital and RF systems and components.
- High stability passive or adaptive mechanical structures.
- Optical and electro-optical components and devices.
- High pointing accuracy control systems.
- Computerized autonomous operating systems for satellite & robotic applications.

One of the major program initiatives in support of Canada's contribution to the International Space Station is the Space Station Mobile Servicing System (MSS). To augment Canadian industrial technological capabilities related to this project, the Strategic Technologies for Automation and Robotics (STEAR) program was created in 1989, at the NRC (later moved the CSA), with funding of $C51 million. Since then, STEAR has awarded over 150 contracts that have involved 12 joint venture funding partners, 77 prime industrial contractors, 85 industrial subcontractors, 29 universities and 30 research centres. Key criteria to obtain support through this program include that the technology must be:

- of potential use in the design and construction of the MSS
- a new technology in Canada or require a significant upgrade of a current Canadian capability
- feasible from both technical and economic points of view, especially in comparison to importing off-the-shelf technologies
- capable of being spun-off for other space or terrestrial applications.

Canadian Space Agency At A Glance

The Canadian Space Agency (CSA) was created in December 1990 to unify space-related activities of diverse federal departments and agencies. There are five major sectors of activity, including space systems, space operations, the Canadian astronaut office, space sciences and space technologies. It provides direct research investments for universities and the private sector.

Table 6 Canadian Space Agency

Type of Activity	State of Participation
Equity investment	No - not permitted (Financial Admin. Act)
Relationship with venture capital	Yes - Canadian Science and Technology Growth Fund (non-exclusive)
Repayable grants for research and development	No
Non-repayable grants for research and development	No
Participation in consortia	Yes - most programs involve technology development consortia (e.g., STEAR, Radarsat)
Support for Innovation Infrastructure	
In kind	Yes
Facilities/incubator	Yes
Expertise	Yes
Promotion/marketing	Yes - limited

3.2 Provincial Research Organizations

InNovacorp

Dartmouth, Nova Scotia,
Total Staff:<50
Total Budget: $C6 million

Major Research & Development Themes

- to create an international perspective for the province's technology -based economic development
- offers a range of technology, commercialization and market development services
- commercialize research and development in Nova Scotia
- develop business incubator facilities
- assist in seed financing and other equity-based investment support
- support regulation and technical standards

InNovacorp At A Glance

InNovacorp is the product of the recent consolidation of the former Nova Scotia Research Corporation, provincial activities concerning industrial parks and incubators, the technology responsibilities of the provincial Economic Renewal Agency and the Nova Scotia First Fund (a public equity investment fund).

Table 7 InNovacorp

Type of Activity	State of Participation
Equity investment	Yes (direct investment and with venture capital partners)
Relationship with venture capital	No
Repayable grants for research and development	No
Non-repayable grants for research and development	No
Participation in consortia	No
Support for Innovation Infrastructure	
In kind	Yes
Facilities/incubator	Yes
Expertise	Yes
Promotion/marketing	Yes

Centre de recherche informatique de Montreal (CRIM)

Montreal, Quebec
Total Staff: 117
Total Budget: $C18 million

Major Research & Development Themes

- Core areas:
    - Knowledge-Based Systems
    - Human-Computer Interaction
    - Software Development Tools and Methods
    - Telecommunications and Distributed Systems
    - Information Highway Applications

- Other interests/activities:
    - Quality systems (ISO 9000)
    - Francoroute (catalogue & index of French-language Web resources)
    - Evaluation of Speech Recognition Systems
    - Application of Robotics Technologies to Forestry Equipment
    - Interactive Image Technologies
    - Agent-oriented programming Language (LALO)
    - High Speed Telecommunications Tools
    - Simpler wireless cellular telephony
    - Ergonomic design

CRIM At A Glance

The Centre, which used to receive most of its funding from governments, has, over the last five years moved to 78% self-sufficiency by forging a close relationship with the industries and businesses that it serves. Its research activities are shaped by market needs and by future impacts of its research on the information technology (IT) industry. CRIM has developed a reputation for high quality research with many published, peer reviewed papers, written by its staff. The Centre is oriented toward enhancing the competitiveness of its members and increasing the pool of professionals qualified to work in the information technology area. CRIM has facilitated the formation of strategic alliances. As a leading IT research centre in a francophone milieu, CRIM has also provided leadership in the use of the French language in IT and on the Internet.

Table 8 CRIM

Type of Activity	State of Participation
Equity investment	No
Relationship with venture capital	No
Repayable grants for research and development	No
Non-repayable grants for research and development	No
Participation in consortia	Yes
Support for Innovation Infrastructure	
In kind	Yes
Facilities/incubator	No
Expertise	Yes
Promotion/marketing	Yes

ORTECH Corporation

Mississauga, Ontario
Total Staff: 268
Total Budget: $C29 million

Major Research & Development Themes

- Automotive technologies
- Medical and pharmaceutical
- Computer modeling
- Technology assessments
- Software testing
- Environmental
- Materials technology

ORTECH At A Glance

ORTECH was founded in 1926 and was known as the Ontario Research Foundation until 1988. Its mission was to solve problems of production and processing for Canadian industries and natural resource developers. During the 1970s and 80s, the mandate extended to include a new emphasis on energy and environmental matters. In the face of declining provincial government grants ORTECH has attempted to develop new business thrusts to off-set the revenue losses. These new initiatives include technology assessments for financial institutions and software testing.

Table 9 ORTECH

Type of Activity	State of Participation

Equity investment	No
Relationship with venture capital	No
Repayable grants for research and development	No
Non-repayable grants for research and development	No
Participation in consortia	Yes
Support for Innovation Infrastructure	
In kind	Yes
Facilities/incubator	Yes
Expertise	Yes
Promotion/marketing	No

Saskatchewan Research Council

Saskatoon, Saskatchewan
Total Staff: 210
Total Budget: $C22 million

Major Research & Development Themes

- Resources and environment
- Agricultural biotechnology services to small business

Saskatchewan Research Council At A Glance

The Saskatchewan Research Council (SRC) was founded in 1947 to assist Saskatchewan industry through applied research and development, technology transfer and the delivery of analytical services. Programs are directed at petroleum, environment, mineral exploration, fermentation and genetics. It provides contract research to government and the private sector.

Table 10 Saskatchewan Research Council

[illegible]	[illegible]
Equity investment	No
Relationship with venture capital	No
Repayable grants for research and development	No
Non-repayable grants for research and development	No
Participation in consortia	No
Support for Innovation Infrastructure	
In kind	Yes
Facilities/incubator	No
Expertise	Yes
Promotion/marketing	Yes

Alberta Research Council

Edmonton, Alberta plus 3 other locations
Total Staff: 460
Total Budget: $C46 million

Major Research & Development Themes

- Agriculture
- Biotechnology
- Energy
- Environment
- Forestry
- Information
- Manufacturing

Alberta Research Council At A Glance

The Alberta Research Council (ARC) was founded in 1921 and is the largest provincial research organization in Canada. Its mission is to advance the Alberta economy by promoting technology development and applications and performing applied research and providing expert advice.

Table 11 Alberta Resource Council

Type of Activity	State of Participation
Equity investment	No
Relationship with venture capital	Yes - Canadian Science and Technology Growth Fund (non-exclusive)
Repayable grants for research and development	No
Non-repayable grants for research and development	No
Participation in consortia	Yes
Support for Innovation Infrastructure	
In kind	Yes
Facilities/incubator	Yes
Expertise	Yes
Promotion/marketing	Yes

British Columbia Advanced Systems Institute

Vancouver, British Columbia
Total Staff:< 20
Total Budget: $C26 million

Major Research & Development Themes

- Principle task is to facilitate linkages between BC industry and universities.
- Funds university research
- Funds university fellows (leaders of world class research)
- Funding of early stage technology companies
- Provides business mentoring

British Columbia Advanced Systems Institute At A Glance

The British Columbia Advanced Systems Institute (BC-ASI) has displaced the former British Columbia Research Corporation (now BC Research Inc.), which has been sold to private interests, as the principal link between government and technology in British Columbia. It originated in providing funding to retain world class researchers in the province or in attracting world class researchers to locate at BC universities. Its scope has been extended to include the nurturing and funding of young technology organizations from both the university and private sector environments. It also administers and manages for the provincial government a technology driven valued added program directed at the forestry sector.

Table 12 BC-ASI

Type of Activity	State of Participation
Equity investment	Yes
Relationship with venture capital	Yes - Canadian Science and Technology Growth Fund (non-exclusive)
Repayable grants for research and development	Yes
Non-repayable grants for research and development	No
Participation in consortia	Yes
Support for Innovation Infrastructure	
In kind	Yes
Facilities/incubator	No
Expertise	Yes
Promotion/marketing	Yes

Table 13 Summary of selected Provincial Research Organizations

Type of activity		N.S.	Quebec CRIM	Ontario ORTECH	Sask. SRC	Alberta ARC	B.C. BC-ASI
Equity investment		yes	no	no	no	no	yes
Relationship with a venture capital fund		no	no	no	no	CSTGF	CSTGF
Repayable grants for R&D (loans)		no	no	no	no	no	yes
Non-repayable grants for R&D		no	no	no	no	no	no
Participation in consortia		no	yes	no	no	yes	yes
Support for innovation infrastructure							
in kind		yes	yes	yes	yes	yes	yes
facilities/incubator		yes	no	no	no	yes	no
networks		yes	yes	yes	yes	yes	yes
expertise		yes	yes	yes	yes	yes	yes
Promotion/marketing		yes	no	no	no	no	no
Ratings - Low (1) to High (10)							
Involvement	High (equity) to Low (in kind)	4	8	1	4	7	8
Dollars transferred	amounts	2	0	0	0	0	5

Notes: N.S. = InNovacorp, Quebec = Centre de recherché informatique de Montréal (CRIM), Ontario = ORTECH (ex. Ontario Research Foundation), SRC = Saskatchewan Research Corporation, ARC = Alberta Research Council, B.C. = British Columbia Advanced System Institute

Table 14 Summary of selected Canadian Federal Government Agencies

Type of activity		Industry Canada	NRC	NSERC	MRC	CSA
Equity investment		nil	nil	nil	nil	nil
Relationship with a venture capital fund		nil	CSTGF	CSTGF	CMDF	CSTG
Repayable grants for R&D (loans)		yes	no	no	no	no
Non-repayable grants for R&D		no	yes (IRAP)	no	no	no
Participation in consortia		PRECARN Canarie	no	indirectly	no	STEA
Support for innovation infrastructure						
in kind		yes (CRC)	yes	no	no	yes
facilities/incubator		yes (CRC)	yes	no	no	yes
expertise		yes (CRC)	yes	no	no	yes
Promotion/marketing		with DFAIT	some	no	no	no
Ratings - Low (1)) to High (10						
Involvement	Low (in kind) to High (equity)	**2**	**9**	**1**	**1**	**5**
Dollars transferred	amounts	**7**	**7**	**8**	**7**	**7**

CSTGF = Canadian Science & Technology Growth Fund. CMDF = Canadian Medical Discoveries

4. Canadian Universities and Venture Capital - Two Models

There are two additional models involving research organizations partnered with industry and universities - The Ontario Centres of Excellence Program and an advanced university model (University of British Columbia) which enjoy linkages with the venture capital community.

The Ontario Centres of Excellence were established in 1987 to link the best of university research with the needs of Ontario industry. This was a response to take the resources of the university - new knowledge, technology and people – and to match these with industry. These were recently consolidated into four Centres of Excellence:

- Materials and Manufacturing Ontario (MMO)
- Communications and Information Technology Ontario (CITO)
- Photonic Research Ontario (PRO)
- Centre for Research in Earth and Space Technology (CRESTech)

Characteristics of the Centres of Excellence include the active sponsorship of university (80%) and industry research (20%) and a program of post-doctorate support in industry research positions. Each of the Centres has been involved in development of commercial enterprises arising out their research activities and in some cases they took equity positions in the new organizations in lieu of repayments in recognition of in kind contributions such as space and office services within the Centres themselves.

Over the past two years all of the Centres have become involved in venture capital activities as some of the new organizations which they were nurturing developed to the point where they required financing beyond the original investment. The Canadian Science and Technology Growth Fund is most active in this regard and has a quarterly program of presentation and review of opportunities with each of the Centres. This has led to two investments to date by the CSTGF together with a pre-positioning of a number of candidates waiting for the achievement of technical or commercial milestones.

The University of British Columbia has developed the most active program of university-industry liaison in Canada. Since 1984, the University-Industry Liaison Office (UILO) helped create 71 companies of which 58 were active in 1997 generating 1,500 jobs. Royalties paid back to UBC by 1997 were $C3.4 million. A point of differentiation for UBC compared to most other Canadian universities was the fact that university in 1997 holds equity positions in 27 of the 58 companies with a market value of $C5.6 million. The UILO is also active in the recruitment of private sector support for research at UBC. In 1997, industry investment at UBC (research budget $C135 million) represented 23 percent of the total university research budget.

5. Canadian Public Research Funding Organizations and Venture Capital - Two Models

In Canada there are two Labour-Sponsored Venture Capital (LSVC) funds which have established formal links with major federal government research and development granting organizations. The Canadian Medical Research Council (MRC) has formalized links (non-exclusive) with the Canadian Medical Discoveries Fund (CMDF). This relationship was established 1994. The MRC is the major federal government funding organization for external medical research activities in Canada (budget $C237 million).

The second linkage is the relationship between the National Research Council, The Canadian Space Agency and The Natural Sciences and Engineering Research Council of Canada (NSERC) with The Canadian Science and Technology Growth Fund (CSTGF). Again, this is a non-exclusive agreement between these organizations. This was established in 1996. For the purpose of this discussion the focus will be on the NSERC relationship, since it is a major federal government external research granting organization (budget $C434 million) in the science and technology area.

The basis of these relationships is a consequence of a series of circumstances, events and personalities. These should be explained to provide a context as to how these new relationships were established between the public research granting organizations and the venture capital community. There are several contributing factors that lead to these relationships including:

- In a period of government financial constraint the funding agencies felt "some pressure" to demonstrate a linkage between their funding activities and a "return on the on investment" relating the creation of wealth in Canada;

- The relatively low level of venture capital activity in Canada engaged in science and technology investment compared to the United States where the combination of technology and venture capital were creating new companies, jobs and new sources of wealth in the late 1980s and early 1990s;

- A feeling that Canada could do very good research but was unable (or unwilling) to exploit the developments stemming from this research. In short, there was seen to be a need for a requirement or incentive for the "good ideas" to meet the money which could develop these "good ideas;"

- A natural "risk aversion" by Canadian investors to invest in early stage, higher risk investments;

- The absence of a "champion" to bring the pieces together to provide an improved environment for investment in the early stage (pre-public market) science and technology field.

In response to this environment the federal government and some provincial governments undertook a series of modifications to various tax acts which provide a new forum to permit individual taxpayers to invest in a mutual type of fund for venture capital activities with these funds sponsored by labour organizations. To provide an incentive the taxpayer could obtain a maximum of a $5,000 tax credit (deduction from income) for investing in one of these Labour Sponsored Venture Capital (LSVC) funds. This tax credit was later reduced to a maximum of $3,500 in 1996. The participating provinces provided an additional tax credit averaging a maximum of $500 annually.

Canadian Medical Discoveries Fund (CMDF)

The champion for this Fund was Dr. Cal Stiller, then head of the multi-organ transplant team at University Hospital in London, Ontario and a prominent medical researcher. Dr. Stiller was the first person to move on linking the research funding organizations to this new tax regime. This opened up an entirely new source of potential investors for science and technology venture capital. In 1994, Dr. Stiller took the initiative to personally provide the initial funding for a new LSVC fund directed at medical research – the CMDF which had formal linkages with the federal government premier medical funding organization, the Medical Research Council (MRC). The CMDF was an enormous success raising $C230 million for investment in its first two years of operation.

The manager of the Fund is MDS Capital which manages five health care related investment funds with a net asset value of $C450 million. The parent company MDS is one of the largest health care operators in Canada. It is involved in clinical laboratory operations, gamma and radioisotope products, mass spectrometry technology, hospital services and products, community health care and pharmaceutical contract services. MDS's revenues in 1996 were $C819 million.

The interface between the fund manager and the MRC is relatively simple. There are regular meetings where there is an exchange of information. MRC, for its part, provides a listing and description of its current funding projects. MDS Capital reports on progress and the state of previous references which MRC provided. Typical CMDF investments are in the range of $C1 million to $C5 million. Note that LSVC funds are limited to a maximum of 10 percent in any single investment.

Also of interest is the CMDF-related University Medical Discoveries Inc. This was established to provide funding to protect intellectual property developed at Canadian universities, hospitals and research institutes. It provides business development expertise,

as well as funding for prototype developments or proof-of-principle demonstrations. It's investments are typically less than $C200,000.

Canadian Science and Technology Growth Fund (CSTGF)

In 1996, Dr. Stiller began to explore the possibility of establishing a separate fund similar to CMDF but in the broader area of science and technology. During the intervening two years the LSVC funds had had major appeal in the retail market raising over $C 1 billion . Approximately 15 new funds emerged in the marketplace only one of which has a science and technology focus and that was limited to enterprises in the province of Ontario.

A new fund, with a national focus, was created again led by Dr. Stiller, namely, the CSTGF which was launched in 1997. Because there was no national equivalent to MDS Capital to act as the manager of the fund a new management company, Technology Investment Management Corporation (TIMCO), was created. As well BeauTech Management Corporation, one of the authors of the present report, was formed to undertake technical due diligence activities on behalf of the CSTGF. Total money raised in the last two years was $C20 million. The lower level of investment, compared to the previous experience of the CMDF resulted from great competition among LSVC funds, attractive performance and competition from mutual funds in general and a reduction of federal tax credit from $C5,000 to $C3,500.

The CSTGF has a number of strategic partnerships with federal and provincial research organizations. In most cases there are regular review meeting with the organizations to report on progress and status of previous references and identify potential new opportunities from the strategic partner.

The CSTGF-NSERC relationship is managed in two ways - direct and indirect. First, many project opportunities are directed to the CSTGF by Canadian universities, which have NSERC funding. Second is a direct reference from NSERC staff to the CSTGF. At the present time the NSERC application forms are being redesigned to obtain the permission of the researcher to permit a possible direct reference or alert to the CSTGF. In the interim, there are quarterly meeting between CSTGF and NSERC to share information of indirect references from the universities.

6. A View of Generation of Intellectual Capital from Research Organizations

BeauTech Management has recently completed a major study on behalf of a large Canadian based public research organization which benchmarked the organization to 13 other research organizations (private and public sector) worldwide. In the process of this study, BeauTech developed a grid which permits the plotting of two basic types of research organizations. These are:

Type "X" organizations whose mandate is determined solely by the current business interest of their client base. Deliverables form Type "X" organizations are closely defined and the technology is transferred under contractual relationships within a corporate envelope. Although effective at meeting the needs of clients, these organizations frequently have difficulty in adding to their intellectual capital. Such an organization in Canada could be a corporate industrial research organization that is dedicated to research for corporate operating divisions;

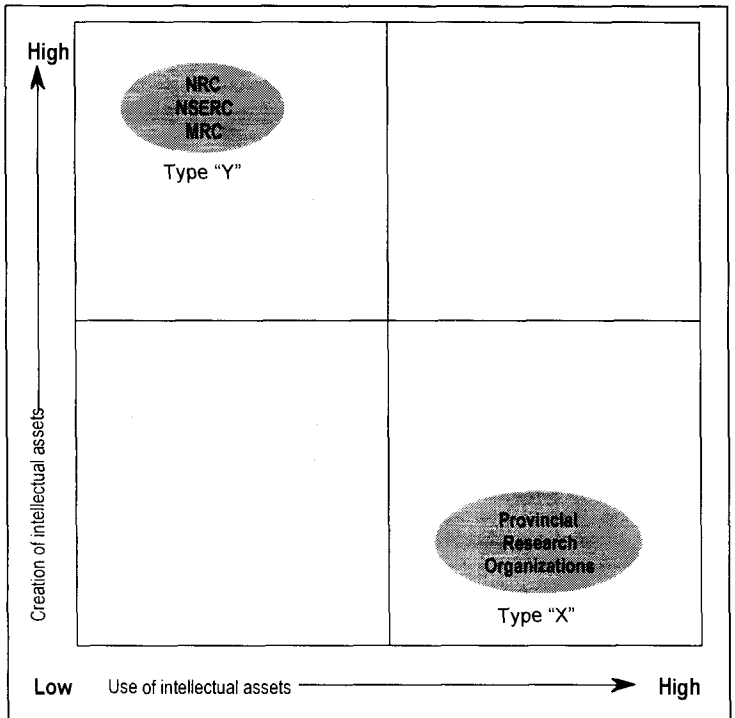


Figure 2 Relative position of various federal and provincial research organizations: *creation* vs. *use* of intellectual assets

Type "Y" organizations are those organizations whose mandate is defined by a scientific charter. Specific deliverables are generally not defined and technical information is made available through publications to the broad scientific network. Although effective at creating intellectual capital, these organizations are usually not involved in the commercial use of this capital. Such an organization might be in a Canadian context, medical research at a Canadian university.

Figure 2 provides an illustration of the relative position of the federal and provincial research organizations at the present time.

7. Conclusions

The conclusions are presented within four groups relating to the Canadian experience of public sector research or innovation based organizations and the role of venture capital in the process of moving innovation from the research organizations to commercialization.

- Building technology or innovation-based organizations
- Role of public sector agencies
- Experience of Canadian and provincial agencies
- General conclusions

1. Building technology or innovation-based enterprises

a) The keys to growing new enterprises in the knowledge-based economy include management of:

i) Risk (hence the value of the venture capital approach);

ii) Assets including human resources and intellectual property;

iii) Linkages at the local-regional level with :

a) research and academic organizations;
b) local entrepreneurs with managerial experience;
c) local infrastructure as needed (e.g., telecommunications);
d) sources of private finance and public funding;

iv) Markets and market intelligence (knowing where to aim);

v) Short vs. long-term considerations.

b) Linkages between research organizations and venture capital organizations are vital to the process of migrating new technologies to the market.

c) There are few realistic alternatives for financing of new technology development that are as effective and flexible as venture capital, especially "knowledgeable" venture capital.

d) This model translates readily from the industrial economies of the North to the emerging economies of the South.

2. Role of public sector agencies

a) Mitigation of risk associated with new technology development and/or technology adaptation/adoption;

b) Growing the human resource pool of talents required for technology-based enterprises;

c) Facilitating linkages internationally with respect to technology and markets.

3. **Experience of Canadian Federal and Provincial agencies**

a) Public research organizations in Canada are at an early stage in "coming to grips' with establishing a new set of relationships with venture capital.

b) Present administrative requirements imposed by federal and provincial government legislation and regulations largely prevent government research organizations in Canada from assuming equity positions in new organizations despite possible origins or past investments by the research organization.

4. General Conclusions

a) The Canadian reality and practice of public/private partnerships represents an alternative to the United States model for venture capital relationship especially for an economy that is one-tenth the size of the United States and does not have the same free-wheeling capitalistic outlook.

b) Melding the needs of academic researchers, who have the knowledge required by industry, to those industrial needs can be a very difficult and subtle art. Academics pursue truth, excellence and prestige; industry pursues profit. Frameworks designed to bring these together must take into account these differing motivations.

c) For emerging economies, a model which is in the southeast quadrant of the X-Y diagram -- representing relatively low building but relatively high use of intellectual assets -- might be most appropriate. Using, applying, adapting technology is often far more cost-effective than building new assets which can be expensive. Nonetheless, over the longer term, these are not independent as even the use of intellectual assets will require the research infrastructure and human resources that are the direct result of "building intellectual assets".